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Survival analysis: A case study of micro and small enterprises in Dolnośląskie and Opolskie Voivodship (Poland)

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Abstract

The aim of the study is to achieve initial recognition of the factors that determine the survival rate of Polish micro and small enterprises. The research, conducted in June 2011 and covering a sample of 147 entities, constitutes a pilot study. We explore the determinants of companies' survival and test whether firms with different characteristics exhibit different performances in terms of the duration of survival. The results indicate substantial differences in the survival rates. The factors taken into account in this study, which to the greatest extent possible differentiates the whole sample in view of survival, are: running the business with employees or alone and specialist vs. popular activity as regards the required competences. Larger firms (with employees) are significantly less likely to close than smaller firms. Firms in highly competitive markets are more prone to closure.

Keywords

Micro and small enterprises, Poland, survival analysis.

JEL Classification: L25, L26, C14

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1. Introduction

The study makes use of so-called survival analysis, which – apart from medical examinations – is applied in various social sciences. Survival analysis is a branch of statistics that deals with death (e.g. firm exit). With the application of survival analysis, for instance, the bankruptcy of newly founded firms (Baldwin et al., 2000) has been studied, as well as the length of strike actions (Greene, 1993) or – similarly to the present study – the survival of companies (Audretsch and Mahmood, 1995).

Survival analysis attempts to answer questions such as: What is the fraction of a population that will survive beyond a certain time?[1] Of those that survive, at what rate will they die or fail? How do particular characteristics increase or decrease the odds of survival?

The aim of the study is to achieve initial recognition of the factors that substantially determine the survival of companies from the group of micro and small enterprises in Opolskie Voivodship and

[1] The survival rate is the proportion of firms surviving the given number of years.

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Dolnośląskie Voivodship.[2] The research constitutes a pilot study. Conducted in June 2011, it covers 147 entities, representing exclusively determined centres of business activity from the areas of Wrocław (Dolnośląskie Voivodship), Opole and Kluczbork (Opolskie Voivodship). Due to the fact that data related to a relatively large number of subjects were not available, it was difficult to take into account typically branch-related factors: basically, none of the branches would be represented in sufficient numbers. Moreover, some of the data were obtained on the condition that the surveyed subject should remain anonymous, even without any access to the information about the branch it represents (information obtained from tax offices). Such a situation necessitated exclusive reliance on the universal features of subjects from different branches. These features were specified in the course of discussions and experts' procedures, and were also based on own observations of the companies' activity. Finally, it was decided to investigate the influence of the following variables on the duration of entities' survival: commencing activity completely *from scratch* or as a continuation of an activity that had been run earlier, running the activity independently or with a group of partners, employing regular workers or relying solely on the work of the entrepreneur and his/her family, the character of the activity (specialist or popular), the character of the market (niche or highly competitive), the type of transaction in relation to its value and frequency, as well as the source of capital.

The following hypotheses were formulated:

H1: Longer experience in the business sector is positively associated with survival.

H2: Running the activity with business partners is negatively associated with survival.

H3: The character of the market (niche or highly competitive) is a significant determinant of survival. A niche market is positively associated with survival.

H4: Larger firms (with a workforce) survive longer than firms acting based on the work of the owner and his family.

H5: The character of activity is a significant determinant of survival. Specialist activity is positively associated with survival.

H6: The type of transaction, due to its value and frequency, is a significant determinant of survival

H7: The source of capital is a significant determinant of survival. A firm's ability to raise financial capital in the form of external debt is positively associated with survival.

[2] A small enterprise is one with fewer than 50 employees, while a micro enterprise is one with fewer than 10 employees.

The remainder of this paper proceeds as follows. The first section presents the aim. In section two, a review of the literature is provided. In the third section, the data and methodology are identified for the empirical work. Section four presents the analysis and discusses the empirical results. Section five concludes.

2. Firm survival: Research background

There is extensive literature on the subject of firm survival. Dunne et al. (1989a, b) use plant-level panel data from the Census of Manufactures to analyse entry and exit from four-digit SIC industries at the establishment and multi-plant firm levels between the five-year intervals of the Census. Dunne et al. (2005) are primarily interested in the role of producer experience in firm survival. Baldwin and Gorecki (1991) analyse entry and exit, paying particular attention to the effects of firm characteristics at the time of entry on the prospects for survival. Other studies investigate exit rates relative to size, scale, organizational structure (Audretsch, 1991), technology (Winter, 1984), market growth (Bradburg and Caves, 1982) and pre-entry experience (Helfat and Lieberman, 2002). Among the factors influencing the survival rate, we also found some characteristics of the branch itself (the rate of increase in employment, the size of the branch, R&D, the size of the investment in the branch and the rate of new firms entering the branch) (Madhoushi and Nasiri, 2011), the innovativeness of the branch and its technological specific character (Audretsch, 1991) and the location of newly established enterprises (urban, suburban, rural areas) (Renski, 2009). Macroeconomic causes of exit include the phase of the economic cycle, macroeconomic instability and the interaction between the two (Bhattacharjee et al., 2009). Environmental conditions and strategic choices at birth are determinants of the survival function of new firms (Geroski et al., 2007).

With respect to firm-specific characteristics, the effect of firm size is examined as a determinant of exit. A large number of studies provide evidence that the probability of survival increases along with the size of the company (Audretsch, 1991; Audretsch and Mahmood, 1994, 1995; Dunne et al., 1989b; Hopenhayn, 1992; Jovanovic, 1982). Audretsch and Mahmood (1995) argue that larger firms may be more likely to be closer to the minimum scale of efficiency to operate efficiently in the market, and are therefore less likely to be vulnerable than smaller firms.

Audretsch and Mahmood (1994, 1995) estimate hazard functions using firm-specific data, but their treatment of scale economies focuses on internal factors while recognition of the technological environment is limited to higher costs due to higher levels of R&D or greater technological uncertainty in more

technologically advanced and dynamic industries. The literature on the role of innovation in firm survival has begun to grow recently, with some empirical studies finding a survival premium for firms that innovate that is independent of the firms' age and size (Banbury and Mitchell, 1995; Cefis and Marsili, 2005, 2006; Christensen et al., 1998). A few studies consider the impact of R&D investments as inputs into the innovation process on firms' survival. Firms that invest in R&D activities are found to have a lower probability of exit than those that do not (Esteve-Pérez et al., 2004; Hall, 1987).

Firm exits are explained by proximate firm-level factors reflected in financial ratios such as leverage, cash flow and profitability (Cuthbertson and Hudson, 1996; Hsu, 2004; Lennox, 1999; Subramanian, 2010; Taffler, 1982; Ueda, 2004; Winton and Yerramilli, 2008).

Crépon and Duguet (2004) underline the influence of the previous statute of entrepreneurs on the labour market (employed or unemployed). Arribas and Vila (2007) introduce the concept of accumulated human capital when firms are created by several individuals. Human capital can indeed be accumulated through a community of individuals. Woo et al. (1989) show that these firms are more successful than those founded by a single entrepreneur. Arribas and Vila (2007) find that they survive longer. Blumberg and Letterie (2008) stress that applicants who intend to remain the single owner are more likely to face credit rationing.

Kaniovski and Peneder (2008) find differences in hazard rates among different types of manufacturing industries distinguished according to the nature of their sunk costs, their reliance on human resources and the inputs from external services. As sectors influence a new firm's survival significantly, it is not surprising that bankers introduce information on sector affiliation in their screening devices. In a very early study, Altman (1968) shows that corporate bankruptcy is indeed highly sector-dependent.

The existence of multi-product enterprises has been explained by pointing to the reduction of risk and uncertainty that can be reached by diversification across product markets (Jovanovic and Gilbert, 1993; Lipczynski and Wilson, 2001). Using data from the U.S., Bernard and Jensen (2007) report that the probability of failure is lower for multiproduct plants than for single-product plants.

In Poland, out of 275.3 thousand economic entities that commenced their business activity in 2009, 77% were active until at least the end of 2010. For a few years now, a tendency toward an increase in the survival rate throughout the first year of entities' activity has been observed in the group of newly founded enterprises. As regards this group, until the end of 2010, 77.2% of the enterprises run by physical persons and 74.1% of the companies that possessed a legal entity managed to survive. The index of the survival rate for enterprises in which the owners and their family members worked themselves amounted to 77.3%, whereas in the case of companies employing regular workers the index was – 75.4%. Taking into account the basic type of activity, the indexes of the survival rate remained above average for enterprises operating in the following markets: human health and social work activities (87.5%), other service activities (84.9%), information and communication (84.7%), professional, scientific and technical activities (83.7%), construction (82.5%), real estate activities (80.2%) and education (78.3%). The index for industrial companies amounted to 71.7%, that is, it was about 6% lower than that for enterprises in total. The lowest index of the survival rate (67.3%) occurred in the group of firms competing in the services market related to providing accommodation and gastronomy. It is interesting to note that the highest indexes of the survival rate are attained by enterprises whose founders hold higher education and represent a technical profile of their professional preparation (GUS, 2010).

Studies on business failures in Poland date back to the late 1990s. The application of linear discriminant analysis to analysing bankruptcy in Poland can be found in the works of Gajdka and Stos (1996), Hamrol and Chodakowski (2008), Mączyńska (2010) and Wierzba (2000).

3. Data and methods

The ideal of statistical sampling is random selection of cases. When substantial knowledge is available about the population under study, statistical sampling is the preferred choice. National statistical offices are typically the best source of the information needed for a sampling frame.[3] However, there are times when random sampling is not possible. When the goal is exploratory research, cases may be chosen for theoretical reasons (Glaser and Strauss, 1967). A purposive sample refers to the selection of units based on personal judgement. This judgemental sampling is in

[3] The National Official Business Register (REGON) is a continuously actualized set of information on subjects of the national economy run as an IT system by means of a central database and local databases. The register contains for example the following information on the above-mentioned entities: name and address of head office, telephone and fax number of the entity's seat and the e-mail address and website, if they are available and submitted by the entity for entry into the register.

some way *representative* of the population of interest without sampling at random.

The pilot study is a small-scale study designed to test the basic theory and evaluate the basic methodology. Our study is limited by its small sample size and non-random sample, reducing the study's power. The basic idea of the sampling technique can be described as follows. The sampling was performed in several steps. The first step was to choose a sample of business centres. In the second stage, a sample of entities within each centre was selected. Instead of seeking representativeness through randomness, including a wide range of extremes would guarantee representativeness to a large extent. We selected three centres of business activity: Wrocław (600 thous. residents), Opole (100 thous. residents) and Kluczbork (25 thous. residents). The logic behind this procedure was that if very different areas are deliberately selected, the aggregate answers obtained from the respondents in these areas will be close to the average. Although an effort was made to collect reliable contact information to allow for the collection of data, it was difficult to contact potential respondents from closed firms. In total, 94 observations from closed firms (64%) and 53 observations from active firms were used in the study.

By using a non-parametric method proposed by Kaplan and Meier (1958), we estimated the duration of survival (Kaplan and Meier, 1958). In the method, so-called censored observations are distinguished as well as complete observations. Censored observations arise whenever the dependent variable of interest represents the time to a terminal event, and the duration of the study is limited in time (by the end of the study period, some enterprises will still be active). Complete observations are ones carried out until the end of the entities' activity (in this case they are firms that had terminated their activity by the end of the study). In total, 94 complete and 53 censored observations were used in the study.

The essence of survival analysis, however, comes down to marking out the survival curve not only for the whole sample examined, but also for the compared firms because of a certain variable of fractions of this sample. Two or more fractions can occur. First, we estimated the survival functions for the survival of enterprises using the Kaplan–Meier method for the full sample. To show how the duration of survival varies according to firm-specific variables, we compared the Kaplan–Meier survival estimates, dividing the full sample into subsamples. The Kaplan–Meier survival estimates for the full sample are shown in Figure 1. We show the survival estimates by firm-specific variable in Figures 2–8. In the study, the fractions are distinguished according to the examined variables: (1) starting the activity *from scratch* or as a continuation of earlier activity; (2) running the activity independently or with a group of partners; (3) employing workers or relying solely on work by the proprietor and his/her family; (4) the character of the activity: specialist or popular; (5) the character of the market: niche or highly competitive; (6) the type of transactions concerning their value and frequency; and (7) the source of the capital. The dependent variable is the duration (time) of survival and whether we are dealing with a censored or complete observation.

In order to test the significance of differences in the survival duration of the groups distinguished as characterized above, a number of tests can be used. The following tests are popularly applied: Gehan's generalized Wilcoxon test (Gehan, 1965a, b), the Cox–Mantel test, Cox's F test, the log-rank test and Peto and Peto's generalized Wilcoxon test (Cox and Oakes, 1984; Namboodiri and Suchindran, 1987). They differ in reliability depending on the size of the sample, the occurrence of censored data and the knowledge of the distribution of variables (Lawless, 1982). There are no widely accepted guidelines concerning which two-sample test to use in a particular situation. Cox's F test tends to be more powerful than Gehan's generalized Wilcoxon test when the sample sizes are small (i.e., n per group smaller than 50). Despite the fact that Cox's F test is estimated to be more reliable than Gehan's generalized Wilcoxon test, the authors decided to apply the latter in the study due to a good adjustment of the test results to those shown in the Kaplan–Meier figures for the individual variables examined. There is a multiple-sample test that is an extension (or generalization) of Gehan's generalized Wilcoxon test, Peto and Peto's generalized Wilcoxon test and the log-rank test. First, a score is assigned to each survival time using Mantel's procedure (Mantel, 1967); next, a chi-square value is computed based on the sums (for each group) of this score.

The value of $p < 0.05$[4] was accepted in the study as representing statistical significance. The analysis was carried out with the use of *STATISTICA*.

[4] If the significance level α had been established as 0.05, then the *p*-value being less than 0.05 would definitely lead to the rejection of the null hypothesis. The higher the *p*-value, the less we can believe that the observed relation between the variables in the sample is a reliable indicator of the relation between the respective variables in the population. In the study, the *p*-value of 0.05 is customarily treated as a *border-line acceptable* error level.

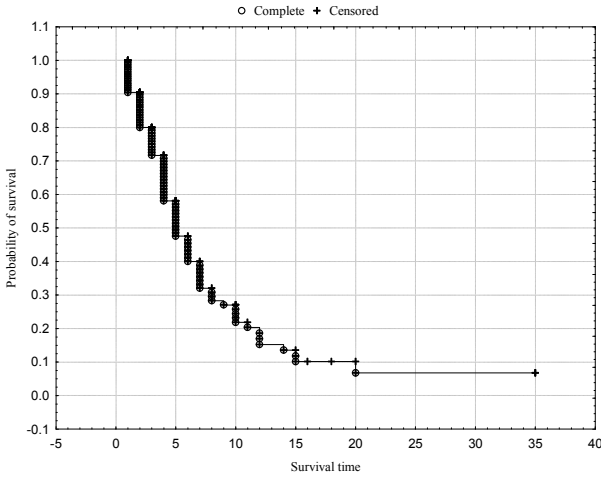

Figure 1 Kaplan-Meier survival estimates (full sample)

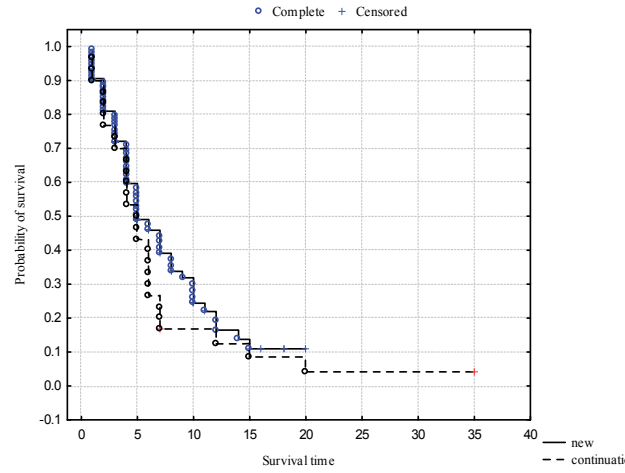

Figure 2 Kaplan-Meier survival estimates (CONTINUATION vs. NEW)

4. Empirical results and discussion

In this section we present our empirical results. The study covered 147 entities, representing the group of micro and small enterprises in Opolskie Voivodship and Dolnośląskie Voivodship. While analysing Table 1, it can be noticed that the probability of continuing business activity in the first year since the moment of registering amounted to 90%.[5] The first quartile life of firms is three years; in other words, 25% will close within three years of their registration. The median life of firms is five years; half will close within five years of registration. The third quartile life of firms is ten years; 75% will close within ten years of registration.

Table 1 Business survival rate – the proportion of firms surviving the given number of years

Year	1	2	3	4	5	6	7	8	10	15
Survival rate	90	80	72	58	48	40	32	28	21	10

Applying Gehan's test, the hypothesis of identical functions describing the probability of survival of economic entities divided into two groups was verified. The analysis carried out did not exhibit statistically significant differences in survival between the examined groups CONTINUATION vs NEW (p = 0.34) (Figure 2), PARTNERS vs NO PARTNERS (p = 0.85) (Figure 3) and COMPETITIVE MARKET vs NICHE MARKET (p = 0.91) (Figure 4). This is also confirmed by Kaplan–Meier survival analysis. The figures below point to only slight differences in survival between the examined groups.

The variable CONTINUATION vs NEW (Figure 2), by assumption, reflects the probable differences in the survival of enterprises that were taken over by a new entrepreneur and were run earlier, for instance, as a so-called family business or were run *from scratch*. Although, in the present study, the variable did not differentiate the sample in a significant way in terms of the survival time, it can be supposed that the continued activity displays a certain kind of advantage of experience (knowledge, skills, connections) and tradition (loyal clientele) over a totally new activity. In the middle part of the figure, between the fifth and the twelfth year of existence, even a contrary phenomenon is marked on the curve – that of a higher rate of abandoning a continued activity than a newly established one.

For the variable CONTINUATION vs NEW, we did not find a significant relationship. Therefore, hypothesis H1 is not corroborated. In contrast, earlier researchers (Audretsch and Mahmood, 1994; Dunne et al., 1989b; Jovanovic, 1982; Mata et al., 1995; Preisendörfer and Voss, 1990) stress experience as a fundamental determinant of firm performance and survival.

The variable PARTNERS vs NO PARTNERS was meant, by assumption, to verify the thesis that running a business activity with a group of partners leads to the appearance of a clash of interests and conflicts, which can affect survival even when the economic situation of the company is good. The variable did not prove to be significant. Despite this, Figure 3 exhibits a situation in which, beginning with the seventh year of existence of enterprises, the survival curves *depart from each other* in a fairly obvious way, and in com-

[5] In Poland, 77% of the economic entities that commenced their business activity in 2009 were active until at least the end of 2010 (see section Firm survival: Research background).

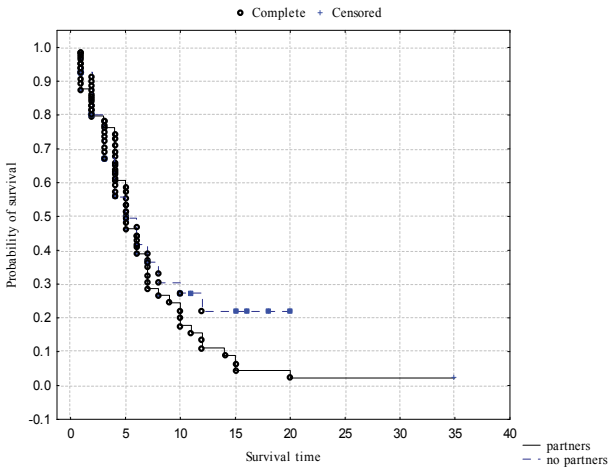

Figure 3 Kaplan-Meier survival estimates (PARTNERS vs NO PARTNERS)

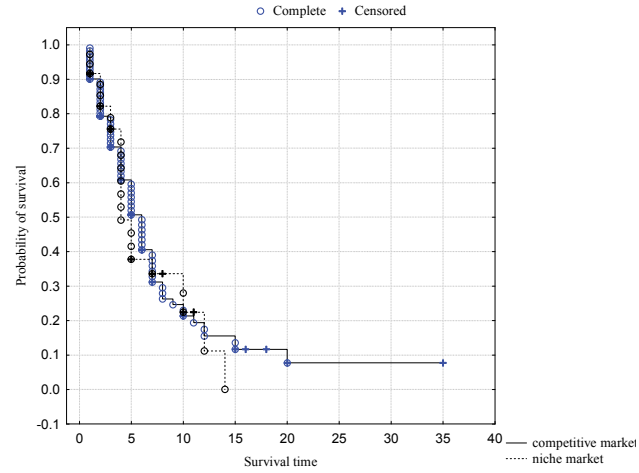

Figure 4 Kaplan-Meier survival estimates (COMPETITIVE MARKET vs NICHE MARKET)

pliance with the assumption that firms run by a circle of partners are liquidated more often than those run as an independent business activity. Therefore, hypothesis H2 is not corroborated. It seems most interesting to learn how the situation would present itself in the case of a representative sample, which requires further, undoubtedly more extensive, research to be conducted.

The picture of the examined group of enterprises in terms of the variable COMPETITIVE MARKET vs NICHE MARKET turns out to be the least interesting (Figure 4). In this case, the curves of the two groups basically depart from each other completely. Generally, there were very few companies that indicated that they operate in a niche market. The decisive majority perceived their markets of activity as competitive ones. It seems that the above differentiation could pose problems related to the proper understanding of the respondents; in addition, it may not differentiate the population of small firms at all, if one looks at the intensive competition within almost every area, even within that of specialist operation. Exceptional instances of a nearly monopolistic situation occur in relation to this group of enterprises (e.g. regeneration of transmission belts), yet, in the study, they simply might not be reflected.

The character of the market (niche or highly competitive) is a not significant determinant of survival. Therefore, hypothesis H3 is not corroborated. The variable does not seem to be of prospective value in view of a possible expansion of the scope of studies in the future.

The differences in the survival of firms employing workers and those based on the personal work of the owner and his/her family (EMPLOYEES vs NO-EMPLOYEES; Figure 5) proved to be significant (p = 0.04). Employing regular workers in a small company is almost always enforced by real necessity and it is a rationally and substantially justified decision. It seems then that the lower liquidation rate for firms employing workers finds its justification in the greater real potential built by human resources in comparison with companies that do not employ workers. Employees of small companies, in a measurable and real way, contribute to their success in the market. On the other hand, they are a certain obligation to the owner and provide motivation to be active. The variable seems to be interesting and with an expanded scope of studies it should be taken into account again.

We found that smaller firms (NO-EMPLOYEES) exhibit the lowest survival probability. The larger the firm (EMPLOYEES), the higher the probability of survival. The results confirm hypothesis H4. This result is consistent with prior studies (Audretsch and Mahmood, 1994; Dunne et al., 1989a, b; Mata and Portugal, 1994).

The most interesting picture emerges in the case of the variable that differentiated the examined group as firms running an activity of a popular character, not requiring specialist competences, and those running a typically specialist activity (POPULAR vs SPECIALIST, p = 0.01; Figure 6). In the case of the latter, a considerable barrier to their entry to the market is formed by knowledge, skills, specialist rights and qualifications, etc. Not every subject can compete in the market of designing, supervision, auditing, counselling, providing specialist services, production, etc. Regarding this case, it is confirmed that the liquidation rate of companies from the group of those undertaking a popular activity is decidedly higher than that of those running a specialist activity Hence, the differentiation in the course of the curves for both distinguished groups is visible from the very beginning of their functioning – from the second/third year. It seems that specialist firms are more difficult to establish and run, but they are – at the same time –

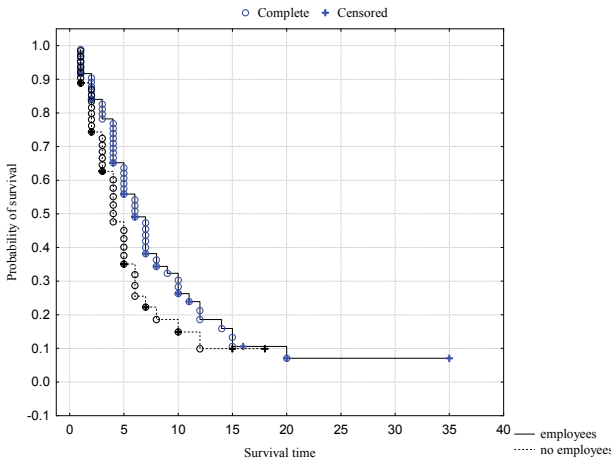

Figure 5 Kaplan-Meier survival estimates (EMPLOYEES vs NO-EMPLOYEES)

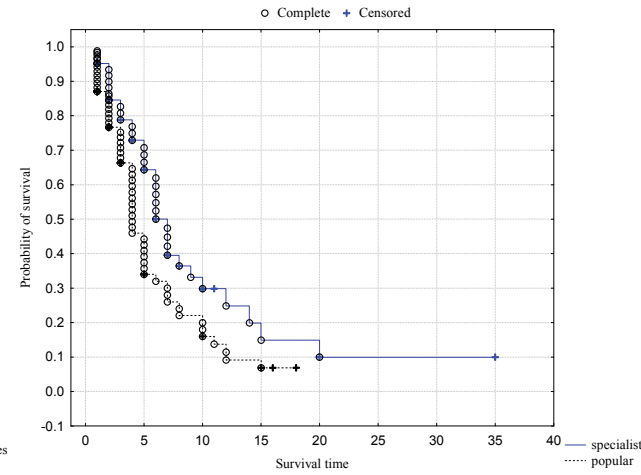

Figure 6 Kaplan-Meier survival estimates (POPULAR vs SPECIALIST)

more resistant to the difficulties that can pose a threat to their activity. It appears that from the point of view of the client, a change of the specialist service provider is harder to accept and burdened with higher transaction costs (harder recognition of the quality of another specialist offer, limited selection of firms offering services, continuation of already commenced projects, etc). Thus, specialist firms build a *portfolio* of more loyal clients, which can turn out to be a component of better results in the range of their survival rate.

The results confirm that the character of activity (POPULAR vs SPECIALIST) is a significant determinant of survival, thus corroborating hypothesis H5. Specialist activity is positively associated with survival.

The hypothesis about identical functions that describe the probability of survival of economic entities divided into four groups due to the frequency and the transaction quota was verified (Figure 7). The analysis carried out exposed statistically significant differences as regards survival between the examined groups (p = 0.03), which is shown in the figure of Kaplan–Meier survival probability. It has to be stressed, however, that the significance of the test results from the differentiation in the course of the function for one of the distinguished groups (high values of transactions, high frequency) with reference to three almost overlapping functions (the options: low values–frequent transactions, higher values–rare transactions, low values–rare transactions). It is not surprising at all that in the case of activities characterized by a very convenient characteristic of high frequency of transactions, connected with high values of the transactions, therefore functioning in very comfortable situational conditions, the survival rate is distinctly higher than in the case of the other options.

The results confirm that the type of transactions in regard to their value and frequency is a significant determinant of survival, thus corroborating hypothesis H6. Convenient characteristics in this scope – high value and frequency of transactions – are positively associated with survival.

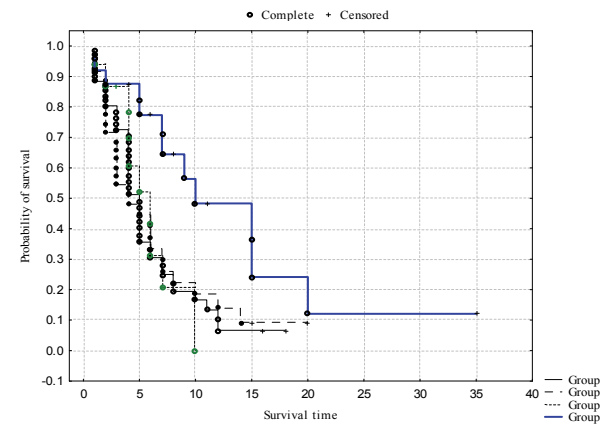

Figure 7 Kaplan–Meier survival estimates (variable: frequency and value of transactions)

Figure 8 points to only slight differences in the survival rate between the individual groups. Equity capital was regarded as the dominant source of capital if its share exceeded 70% of the total capital; on the other hand, debt capital was considered the dominant source if its share exceeded 60% in total. The intermediate situation (EQUITY–DEBT) occurred when the share of equity capital amounted to more than 40% and less than 70%. The variable reflects a dilemma of managing a business: is it better not to bear the financial costs of servicing a debt and be active on a smaller scale or vice versa? The dilemma can take on the following form: is it better to bear the financial costs of servicing a debt and move within a domain that is more commercially profitable, or remain with no debt inside a less profitable one? The answer is conditioned

by the given situation and there is no one model in this respect. When the motivations, business strengths, health and profitability of the branch are at a high level, one can take out loans. If not, it is probably more reasonable to stay with a minimal level of debt. It may be that, due to strong determination caused by the situation, the variable did not turn out to differentiate vitally the examined group of enterprises. Maybe it also requires more precision in broader-scale research since the very source of capital itself – in view of the subsequent changeability of capital structure – cannot be of a decisive character.

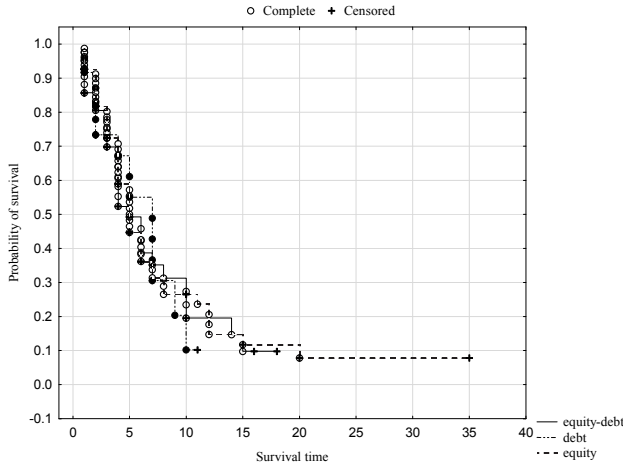

Figure 8. Kaplan-Meier survival estimates (EQUITY vs DEBT vs EQUITY–DEBT).

No statistically significant differences were noticed concerning the survival between the examined groups distinguished due to the source of capital: EQUITY vs DEBT vs EQUITY–DEBT (p = 0.92). This is confirmed by Kaplan–Meier survival analysis. Therefore, hypothesis H7 is not corroborated.

5. Conclusion

The application of survival analysis to the monitoring of micro and small enterprises' survival seems to be justified on the basis of the results obtained and can enrich the knowledge about the functioning of small businesses with some information of a practical nature. Although the study is a pilot, it has outlined hypotheses related to greater chances of survival in the case of enterprises that invest in highly specialized business activity with the component of *know-how* in comparison with those that carry out a popular activity regarding the required competences. Also, small firms that employ a workforce appear to obtain a competitive advantage over micro companies in which the work is performed solely by the owner and, eventually, his/her family. Undoubtedly, in order to strengthen the conclusions, it is necessary to conduct research on a representative sample selected completely randomly. This is not an easy task in view of the great number of entities belonging to the class and their high level of fluctuation. Obviously, different regional determinants, such as economic growth, unemployment rates or knowledge spillovers, may play a role.

Enterprises displaying convenient characteristics of a high frequency of transactions, connected with relatively high values of the transactions, were characterized by a clearly higher survival rate; the variable seems to reflect the specific character of the branch and can be an indicator to select carefully and thoroughly the domain of activity by the entrepreneur at the stage of commencing the business activity. It would also confirm the justifiability of the application of a simplified strategic analysis of domains that can be chosen.

The variables related to the continuation of activity or starting it from scratch, the presence or lack of partners, the competitive or niche character of the market and the source of capital at the beginning of business activity did not differentiate the examined group of enterprises to any significant degree.

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